Technology Opportunity

Miniature Plug-Type Heat Flux Gage

The National Aeronautics and Space Administration (NASA) seeks to transfer a durable heat flux gage that has been proven to measure high heat fluxes and temperatures.

Potential Commercial Uses

- Measurement of surface heat flux and surface temperature in gas turbine, rocket engines and high heat flux facilities
- Measurement of temperature and heat flux in compressor and turbine research facilities

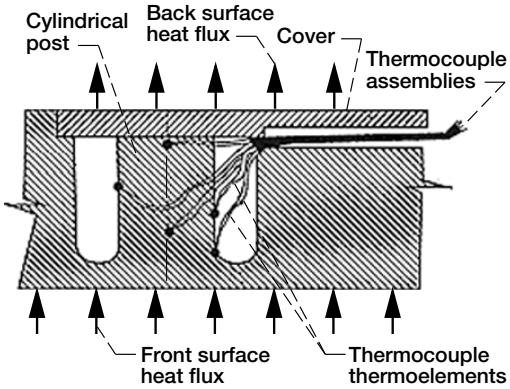
Benefits

- Continuously measures transient and steady-state heat fluxes
- Can be applied over a large temperature range (has been demonstrated from –250 to +2200 °F)
- Can be used over a large heat flux range (as been demonstrated from 3.2×10^3 to 6.7×10^6 Btu/hr-ft^2)
- Can be applied over a large pressure range (has operated at pressures from 0.1 to 2000 lb/in.^{2})
- Accuracy is not seriously affected by temperature gradients across the face of the gage
- Gives a measure of the actual temperature distribution in the direction of transfer
- Can be fabricated directly into the component material by electrical discharge machining

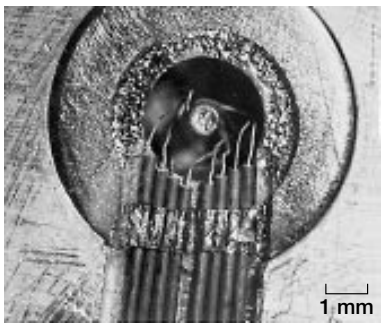
The Technology

Efforts to develop methods for measuring transient and steady-state heat flux have been ongoing for more than 30 years at NASA Lewis Research Center. In the past, a common procedure for installing heat flux gages consisted of press-fitting cylindrical plugs into holes machined into rocket engine combustion chambers and nozzles. Temperatures were measured along the length of the plugs with wire thermocouples. Heat flux was estimated by using the temperature data along with inverse heat conduction analysis. However, after the engines had been operating for a while, hot spots or temperature disruptions occurred at the seam or line of junction between the plug and nozzle material. These hot spots weakened the material, causing cracks, ridges, and grooves that distorted the surface profile. When this happened, the thermocouple signals were so noisy that an accurate heat flux determination could not be made. Eventually, the thermocouples were destroyed.

Recently it became necessary to more thoroughly characterize hot-gas boundary layer environments on the surfaces of stationary airfoils in a ground-based turbine blade tester. This tester is used to simulate the high heat flux environment of turbines driving the space shuttle main engine turbopumps.



Sideview of gage for measuring heat flux on two surfaces.



Back surface without cover.

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Clearly, the method of press-fitting thermocoupled cylinders into materials is not satisfactory for this application. Thus, new methods for measuring heat flux had to be devised. As a result, miniature plug-type heat flux gages, which are an improvement over the earlier gages, have been invented. The gages have been used to successfully measure high heat flux in an arc lamp and a turbulent flow arc jet facility.

Options for Commercialization

Two patents have been granted for this new gage: "Plug-Type Heat Flux Gage," U.S. Patent Number 5,048,973 (Sept. 1991) and "Method of Producing a Plug-Type Heat Flux Gage," U.S. Patent Number 5,086,204 (Feb. 1992). These miniature heat flux gages may be applicable in industries that manufacture thermal instrumentation and arc lamp systems, and in the aerospace industry.

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Key Words

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